Inland Waterways Conference 7 March 2007

Improved Hydrodynamic Design/Detection and Evaluation of Scour at Dams

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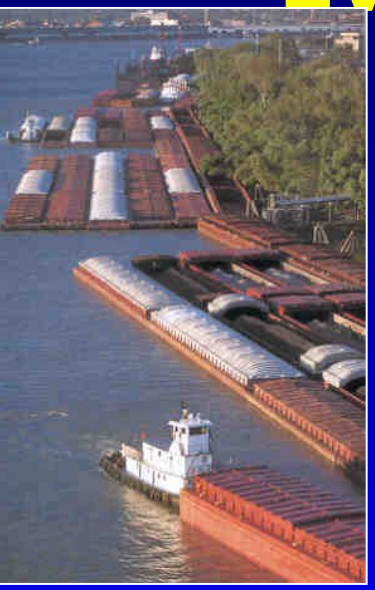
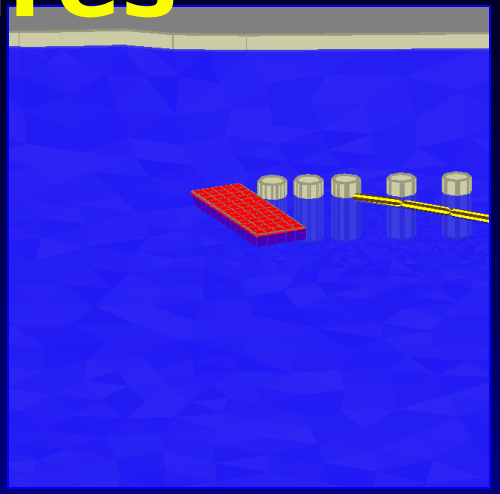
Navigation Branch



Hydrodynamic Design of Inland Structures

- PI: Richard Stockstill & Mark Hopkins
- Challenges
  - Model ice and debris at locks.
  - Integration of structural and hydraulic modeling (Ice & debris, tows, guard walls, gates, barge impacts)
- Final Products
  - Coupled ADH/DEM code to simulate fluid/structural interaction locks and dams.



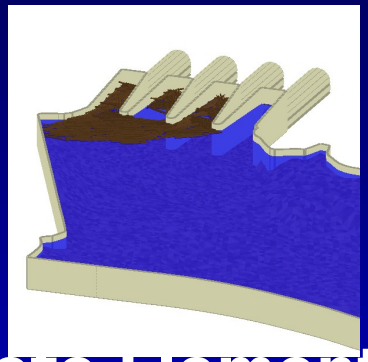
- Benefits: Simulation Tool
  - Unique ability to model fluid/structure interactions.
  - Placement of emergency lock bulkheads and dam gates. (hydraulic forces during placement).
  - Placement of float-in lock components.

Hydrodynamic Design

ADH – ADaptive Hydraulics Numerical Flow Model

Suite of finite element models including

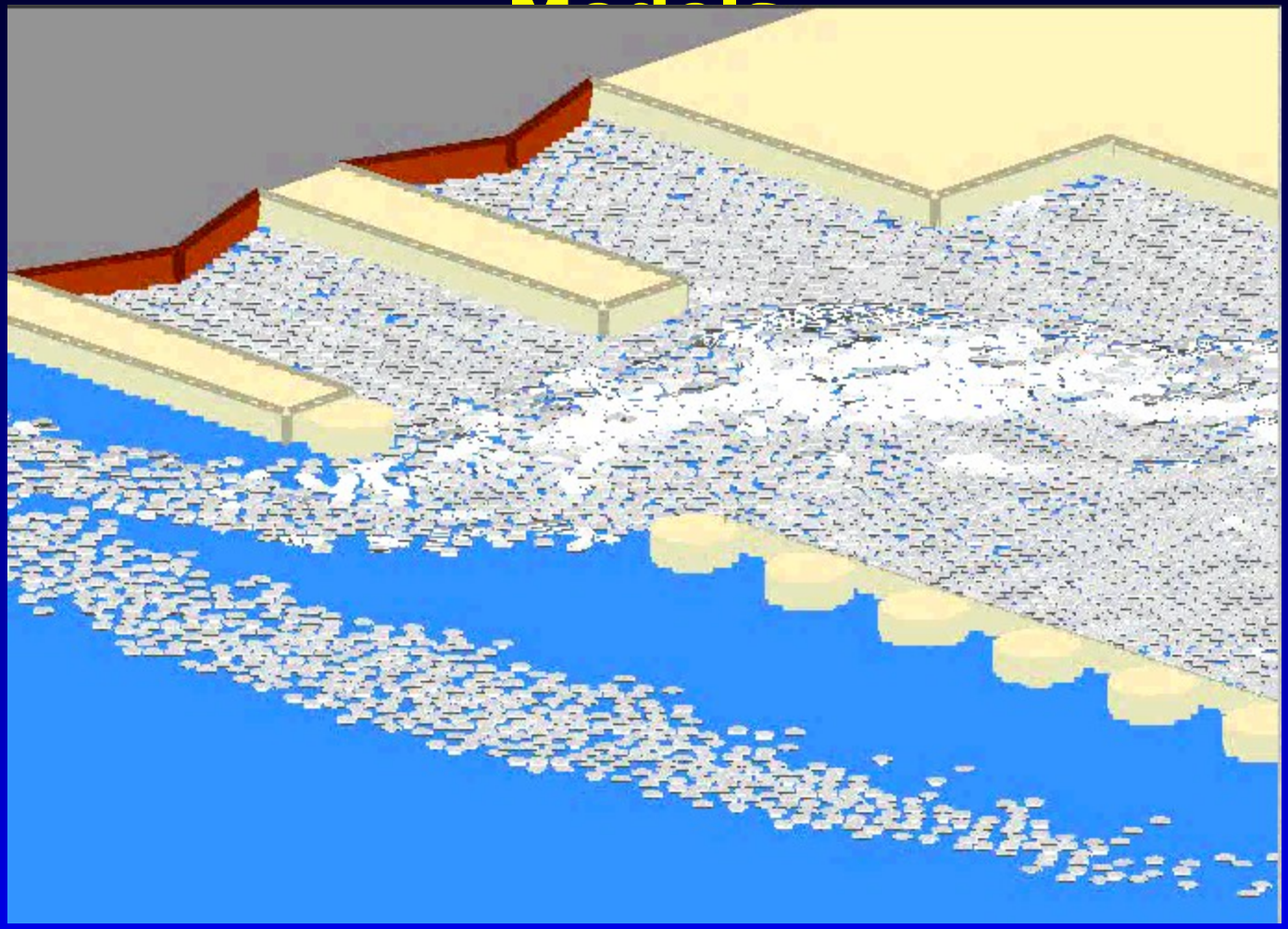
2D shallow-water and 3D Navier Stokes modules



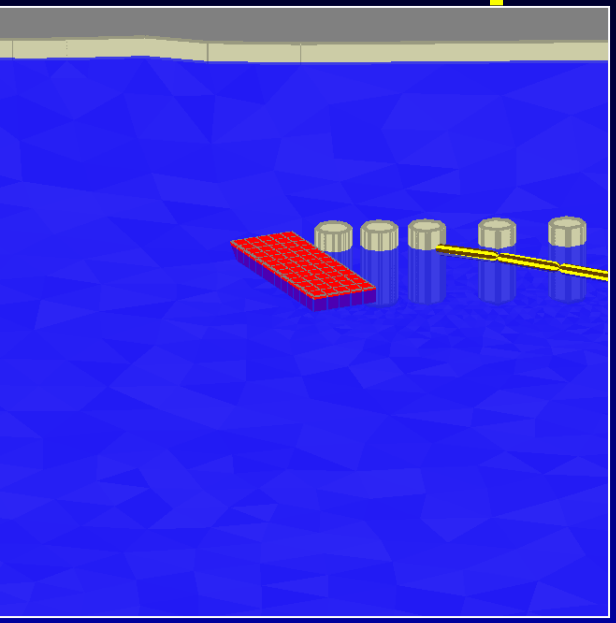
DEM - Discrete Element Mode

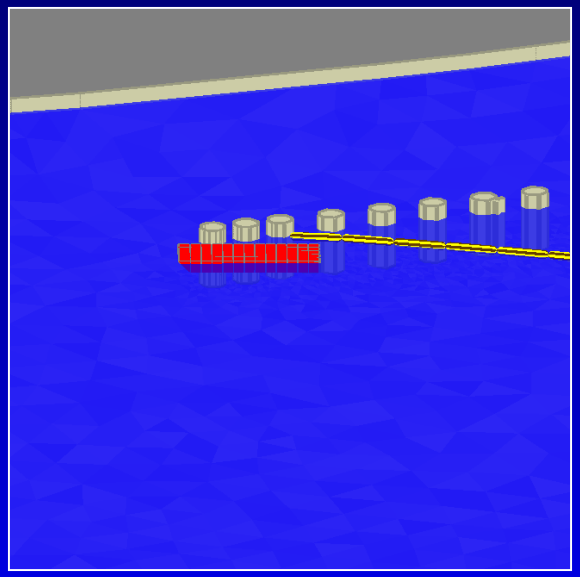
A computer program that models the dynamics of a system of discrete particles ie. ice, debris, barges

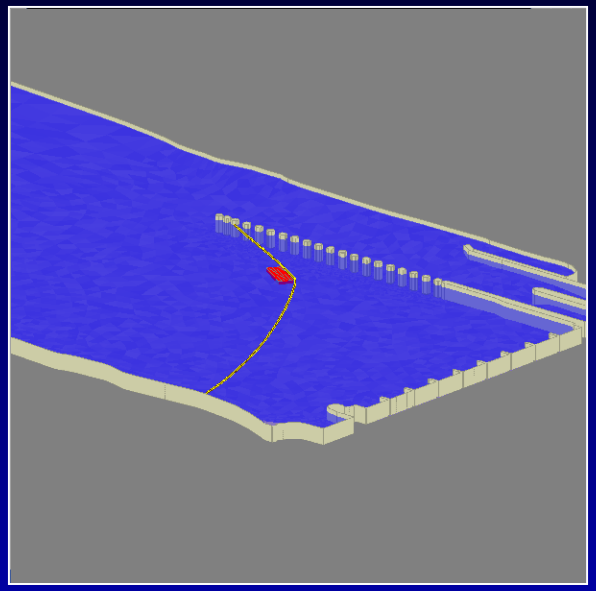
Concept Design for Ice Passage Gap in Guard Wall from Coupled ADH and DEM Models



Concept Design for Vessel Barrier from Coupled ADH and DEM Models







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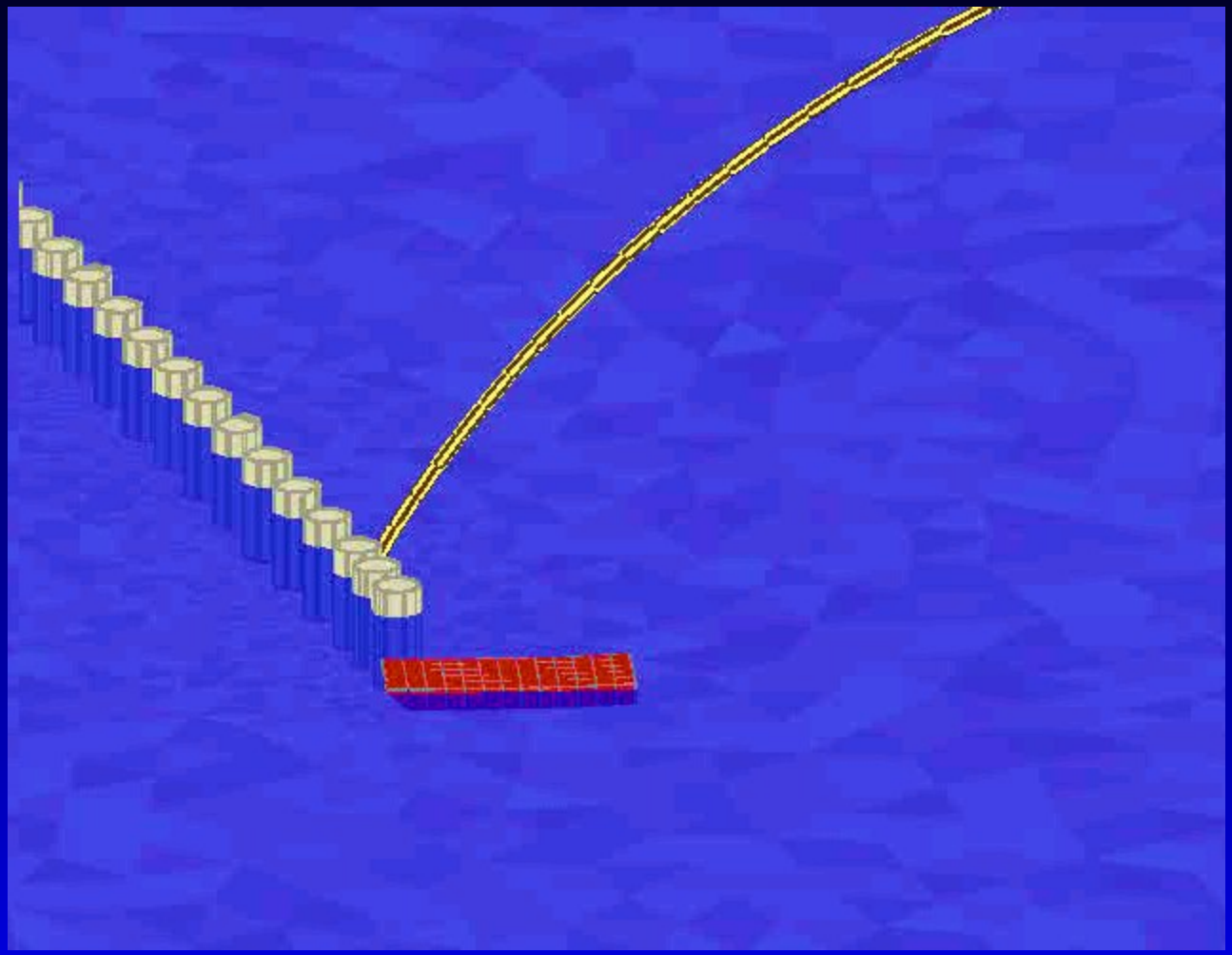


Detection and Evaluation of Scour Protection

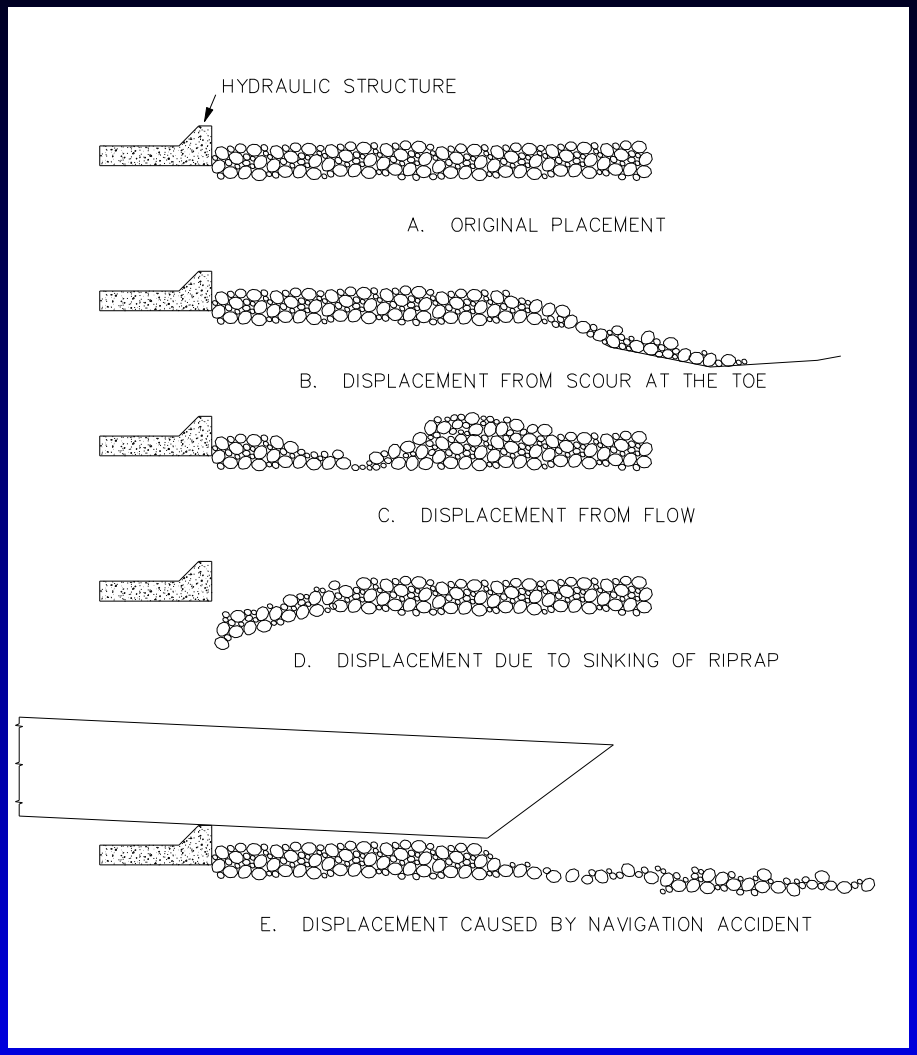
- **PI: John Hite**
- **Problem:**
  - Scour at dams reduces project reliability; Age, extreme flow events, barge accidents can cause scour protection problems; need better tools and guidance for measuring and predicting scour
- **Products:**
  - Demo project (Starved Rock Dam) – 07/06
  - Recommendations for tools/techniques for scour detection – 09/07
- **Benefits:**
  - Process to assess repair needs
  - Better prediction of maintenance/rehab costs
  - Reduced chance of failure

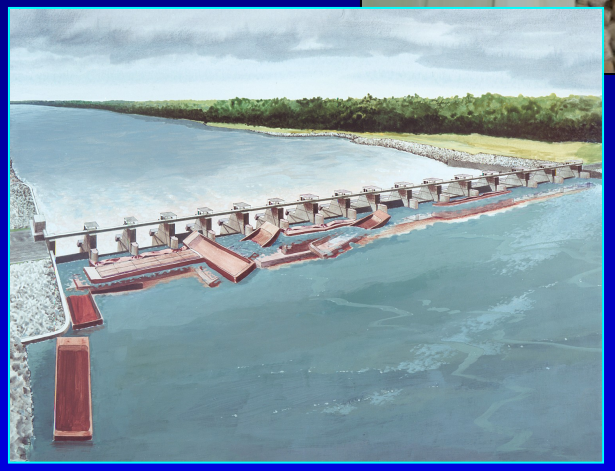
Underwater Imaging

Illinois Waterway Pr

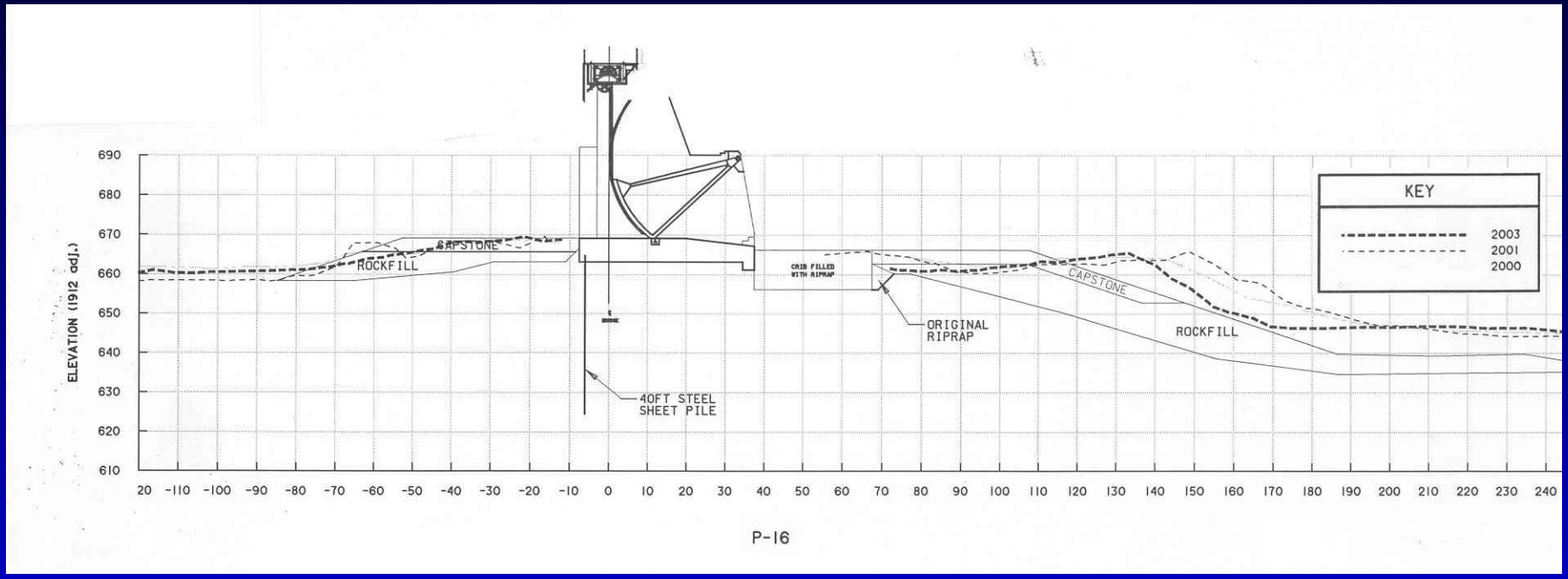
Barge Accident- Ohio River

Causes of Scour


HYDRAULIC STRUCTURE
A. ORIGINAL PLACEMENT
B. DISPLACEMENT FROM SCOUR AT THE TOE
C. DISPLACEMENT FROM FLOW
D. DISPLACEMENT DUE TO SINKING OF RIPRAP
E. DISPLACEMENT CAUSED BY NAVIGATION ACCIDENT



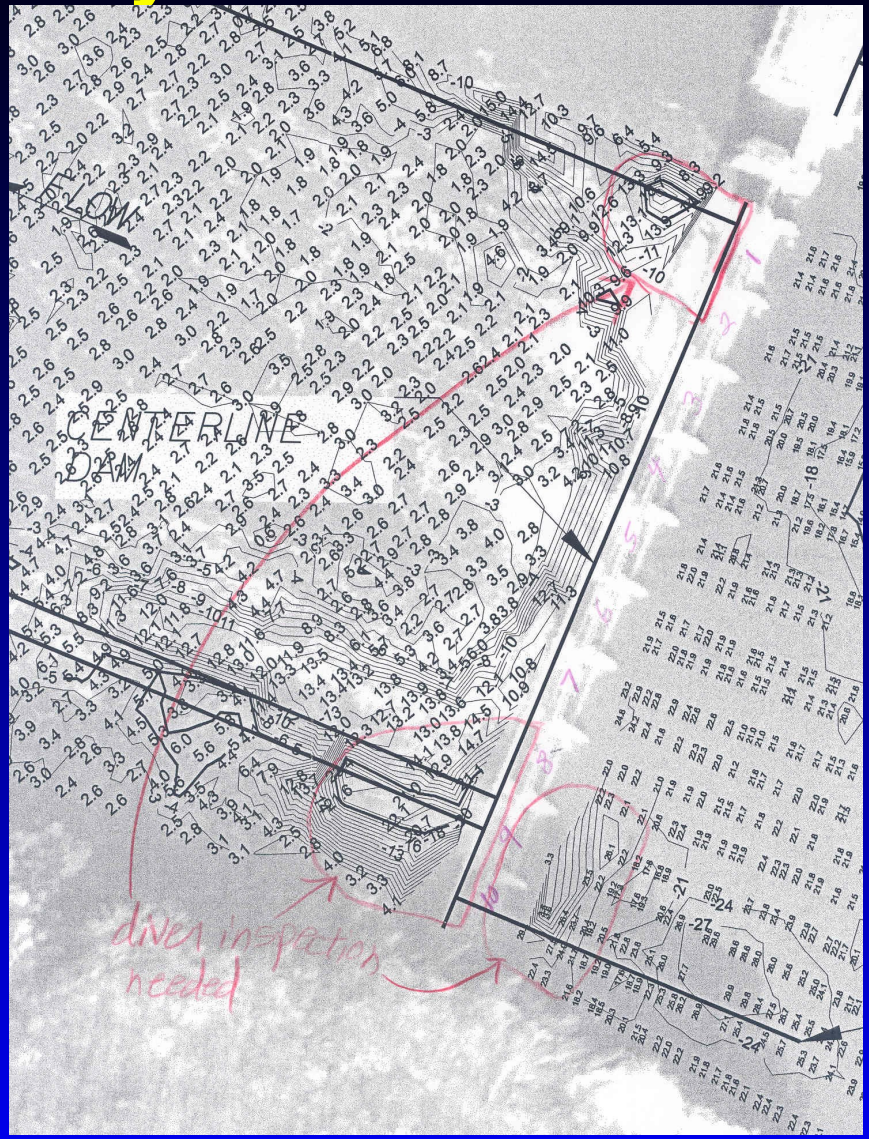
Scour Profiles from Periodic Inspections



Dam 2 on the Mississippi River

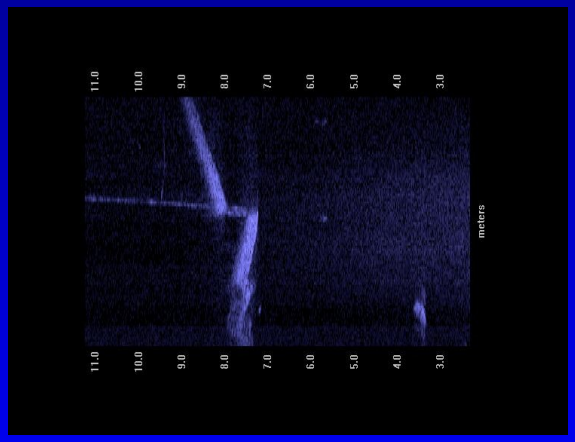
Water Depths from Hydrographic Surveys

Starved Rock Dam on the Illinois Waterway



Acoustical Camera Demonstration

Tracking Total Station for



Engineering Parameters for Risk Analysis

- **Stone Size,** D_{50}
- **Riprap Stability Coefficient,** C
- **Stone Weight,** ζ_s
- **Unit Discharge,** q
- Depth over Basin, d

Determine Reliability of Scour Protection

Example: Point Estimate Method

$$\beta = \frac{\ln\left(E[C]/E[D]\right)}{\sqrt{V_C^2 + V_D^2}} = 1.03$$

Determine Reliability of Structural Components

- Pile Supports for Stilling Basin
- Stilling Basin Concrete
- Steel Sheet Piling
- Gated Dam

Possible Outcomes from Analysis

- Immediate Rehabilitation
- Fix-as-Fail
- Advanced Maintenance

ERDC Points of Contact

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